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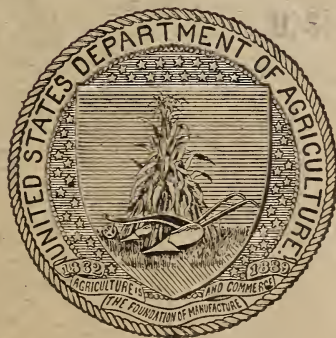
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Issued September 29, 1909.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—BULLETIN No. 62.
MILTON WHITNEY, Chief.

FERTILIZERS FOR COTTON SOILS.

BY
MILTON WHITNEY.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

BUREAU OF SOILS.

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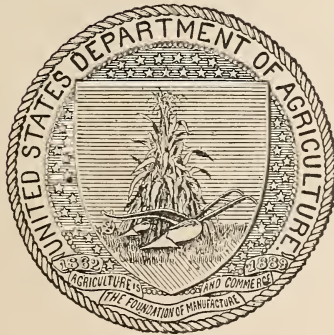
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS,

Washington, D. C., July 15, 1909.

SIR: In order to establish certain fundamental principles regarding the effect and efficiency of fertilizers on cotton soils, I have had compiled all the available results of plat tests with fertilizers on cotton soils which have been carried out by the experiment stations.

It is believed that this matter will be of considerable interest to the farmers of this country, and I therefore have the honor to recommend that the article be published as Bulletin No. 62 of the Bureau of Soils.

Very respectfully,

MILTON WHITNEY,
Chief of Bureau.

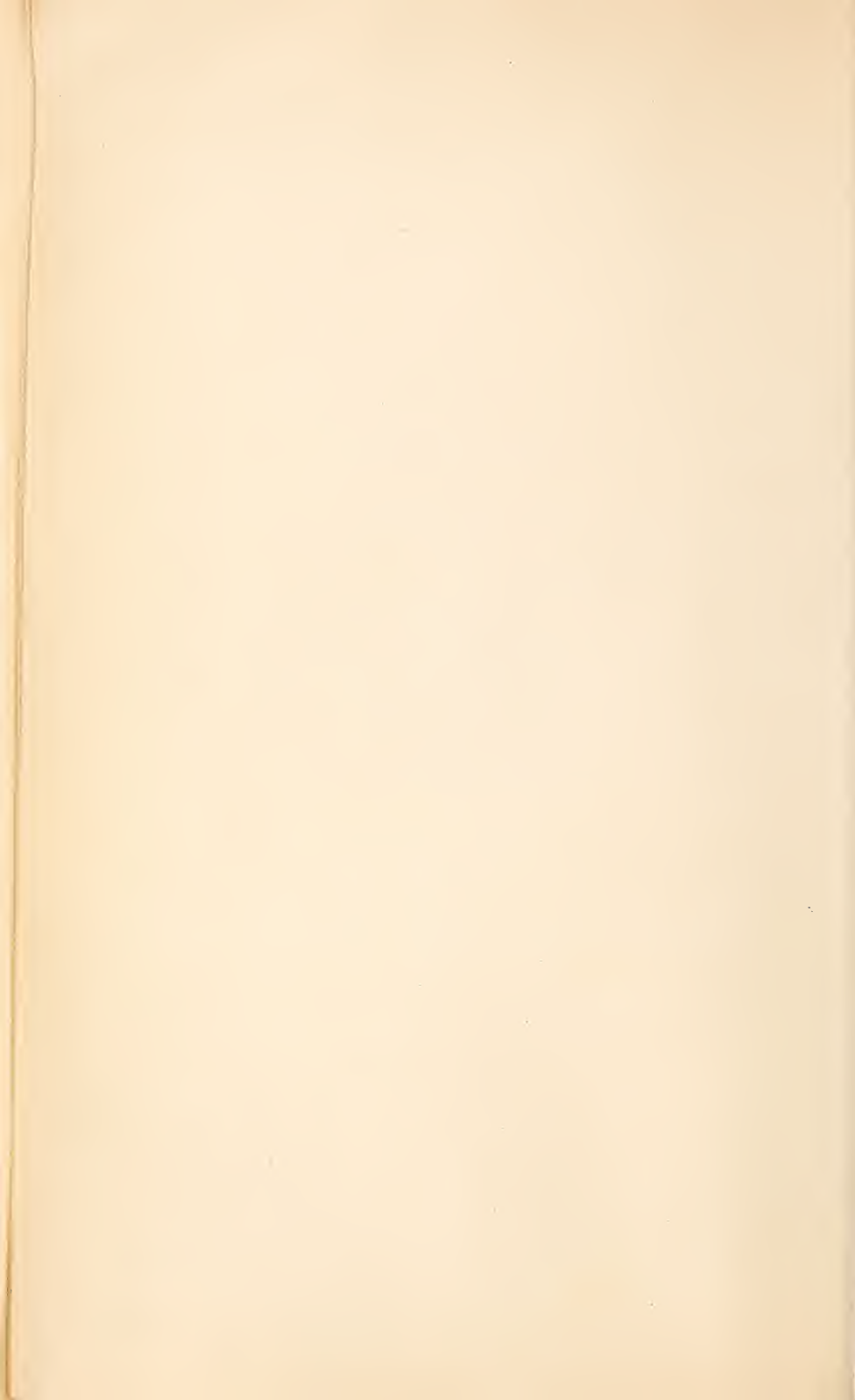
HON. JAMES WILSON,
Secretary of Agriculture.

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FERTILIZERS FOR COTTON SOILS.

INTRODUCTION.

One of the first lines of investigation taken up by the experiment stations was the fertilizer requirements of soils for different crops. During the twenty-one years from 1887, when the first results were reported, to 1907, inclusive, the stations have recorded in their reports and bulletins the results of 2,802 tests of substances applied to cotton soils. The results of these tests are summed up in the following pages.

Each test represents some single substance used alone or some combination of substances and every result has been taken where the yield of a "check" or unfertilized plat has been recorded, where the amount of each substance per acre could be determined, and where the yield or increased yield per acre of cotton could be found. Where the results are given in pounds per plat or per acre of seed cotton the figures have been reduced to one-third to express the yield in lint cotton.

The results have been accepted whether the plats were located on the station farm or the experiments were carried out by cooperating farmers. No experiments from any other source, not accepted and adopted by the stations and rendered in their official publications, are considered in this bulletin.

NUMBER OF EXPERIMENTS.

The number of individual fertilizer tests on cotton soils in the experiment station literature for each year since their establishment is given in the following table:

The number of individual tests on cotton soils reported for each year from 1887 to 1907, inclusive.

Year.	Number.	Per cent.	Year.	Number.	Per cent.	Year.	Number.	Per cent.
1887.....	94	3.4	1895.....	34	1.2	1903.....	92	3.3
1888.....	355	12.7	1896.....	53	1.9	1904.....	57	2.0
1889.....	702	25.1	1897.....	41	1.5	1905.....	36	1.3
1890.....	238	8.5	1898.....	100	3.6	1906.....	59	2.1
1891.....	185	6.6	1899.....	15	.5	1907.....	57	2.0
1892.....	237	8.5	1900.....	2	.0			
1893.....	279	9.9	1901.....	61	2.2			
1894.....	56	2.0	1902.....	49	1.7			
						Total.	2,802

It will be seen that the greatest amount of work done was in the six years from 1888 to 1893, when 1,994 tests, or 71 per cent of the whole number, were recorded. In the year 1889 alone 702 tests were recorded, or 25 per cent of the whole number reported. Since 1893 the number of tests made each year has been small, averaging about 50 for all the stations as against 332 for each of the six years above mentioned.

The following table shows the number of tests recorded in the publications of each State. North Carolina stands at the head of the list with 613 recorded results, and South Carolina is a close second, with 584 tests, while Louisiana follows with 552 results.

Fertilizer plat tests on cotton soils, arranged according to the number of individual tests made in each State from 1887 to 1907, inclusive.

State.	Number.	Per cent.	State.	Number.	Per cent.
North Carolina.....	613	21.9	Alabama.....	169	6.1
South Carolina.....	584	20.8	Arkansas.....	135	4.8
Louisiana.....	552	19.7	Texas.....	58	2.1
Georgia.....	388	13.8	Total.....	2,802
Mississippi.....	303	10.8			

YIELDS ON "CHECK" PLATS.

The investigations have been made under a wide range of soil or of climatic conditions, or both, as measured by the yield of the unfertilized or "check" plats. The following table gives the individual and average yield of lint cotton on the "check" plats when more than one such plat has been used and separately rendered.

It will be seen that these yields without manurial treatment have ranged from an average of 19 pounds to 828 pounds of lint cotton per acre.

Unfortunately, owing to the generally inadequate description of the soils in the reports of these experiments, it was found impracticable to group and analyze the data with relation either to physical or chemical differences in the soils, and the grouping employed—natural productiveness as evidenced by the yields on the unfertilized plats—was chosen as the best available.

Yield of lint cotton, in pounds per acre, on unfertilized plats when more than one such plat is given.

Yield.	Average.	Yield.	Average.	Yield.	Average.	Yield.	Average.	Yield.	Average.
<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
19	19	17	72	103	110	120	168	193	257
19		73		117		140		230	
19		127				140		253	
7	20	69	73	70	120	140	180	267	320
17		75		100		147		283	
37				150		187		287	
	23	64	76	160	128	200	188	287	332
17		75				153		272	
17		88		83		207		336	
35	30		80	177	132		204	352	347
24		70		101		103		260	
36		79		172		157		260	
	37	93	83		133	303	207	477	359
16		80		119		147		333	
48		87		148		261		347	
48	39		86		133		219	360	429
37		76		118		150		367	
40		95		147		155		402	
	43	91	93	110	135	240	221	306	445
43		96		120		357		367	
43				150				402	
	48	93	94	160	141	140	227	359	455
35		95				187		367	
61				137		197		423	
	48	100	95	143	144	220	233	490	491
47				143		353		392	
48		80		141		163	235	467	
50	50	80	97	143	147	247		429	455
		130		147				461	
13				133		197	243	461	
47	52	93	98	150	153	221		429	491
90		100		157		261		480	
		100					249	487	
41	63	91	107	147	154	223		495	530
50		112		160		243		480	
64		117				208	243	495	
	65	90	108	147	156	262		487	570
61		100		161		147	274	500	
63		133				267		510	
66	68		109	149	167	283		630	828
37		91		155		240		559	
75		112		165		250		581	
83	68	121				257	274	761	828
				143		203		761	
59		57		177		345		848	
67		110		190				945	
80		160							

It will be seen from this table that the yield of duplicate plats are not all that could be desired for scientific work of this character. For instance, when duplicate plats from which averages are derived for comparison with fertilizer treatments vary from 13 to 90; 17 to 127; 70 to 160; 83 to 177; 120 to 200; 140 to 353; 480 to 630; and 761 to 945, as some of these do, no strict or exact quantitative comparison can be made from observed differences due to fertilizer treatment. This fact must be borne in mind in interpreting or applying the results in the following tables and decidedly less weight should be given to the results from a few experiments than to the averages from a great many.

LIMITED PERIOD OF EXPERIMENTS.

Another fact that must be mentioned is that in a great majority of cases these tests have been for single years on the same soil, or continued at most for two or three years in the same field. It is well known that the character of the season and particularly the variations in the amount and distribution of the rainfall, which in turn affects the moisture content of soil, influences to a very large degree the relative productivity of a soil from year to year. To overcome these seasonal variations and minimize or equalize their influence it is generally believed that fertilizer experiments should be continued on the same land for a long series of years to establish definitely the fertilizer requirements of a soil. In reporting the results of twenty-five years' continuous experiments with commercial fertilizers on the same land, Hunt^a states as to the interpretation of the results of plat experiments:

No attempt will be made in this article to discuss the data at length, but only to point out some of the more salient facts which have developed through twenty-five years of experimentation. A. D. Hall, referring to the plat experiments at the Rothamsted Station, which have been in progress sixty or more years, recently stated that had the experiments terminated at the end of forty years they would not have been able to give their present interpretation to the results. With this fact before us it is not wise to attempt too wide or too positive generalizations from the results of twenty-five years of field experiments.

It is believed, however, that a careful analysis of the results presented by the experiment stations, embracing, as they do, a large number of soils and climatic conditions, will show some general principles of fertilizer efficiency which it will be well to review at this time.

KINDS AND COST OF THE FERTILIZERS USED.

In the 2,802 tests that have been reported there have been used 35 substances and 71 different combinations of these substances, and there have been many different proportions of the several ingredients in the combinations.

In computing the relative efficiency, from a commercial standpoint, of the several substances which have been used in the fertilizer tests some arbitrary value must be assigned to each which will represent, as fairly as possible, the average cost to the farmer in the several States. However, when these values for any reason do not represent local market conditions, the data contained in the subsequent tables are sufficient to enable a recalculation to be made on any new basis of value.

^aAnnual Report Pennsylvania State College, 1908, p. 69.

The values used in computing the commercial efficiency of fertilizers in this bulletin are given in the following table:

Valuation of fertilizer ingredients used in plat tests on cotton soils.

Ingredient.	Cost per ton.	Ingredient.	Cost per ton.
	<i>Dollars.</i>		<i>Dollars.</i>
Nitrate of soda.....	50.00	Fish scrap.....	40.00
Sulphate of ammonia.....	62.00	Tankage.....	26.00
Dried blood.....	40.00	Compost.....	.50
Floats.....	8.00	Manure.....	.50
Acid phosphate.....	14.00	Cow manure.....	.50
Rock phosphate.....	9.00	Gypsum.....	8.00
Basic slag.....	12.50	Lime.....	6.00
Ground bone.....	26.00	Oyster shells.....	(a)
Muriate of potash.....	44.00	Leather scrap.....	(a)
Sulphate of potash.....	60.00	Wood ashes.....	5.00
Nitrate of potash.....	50.00	Salt.....	8.00
Silicate of potash.....	(a)	Marl.....	.50
Kainit.....	12.00	New Jersey greensand marl.....	(a)
Boneblack.....	22.00	Copperas.....	(a)
Cotton seed.....	16.00	Commercial fertilizers.....	20.00
Cotton-seed meal.....	25.00	Cowpea vines.....	(a)
Cotton-seed hulls.....	4.50	Corn stover.....	(a)
Cotton-seed-hull ashes.....	34.00		

a Not valued.

VALUE ASSIGNED COTTON.

For the purposes of this comparative study the value to the farmer of lint cotton has been taken as 10 cents per pound, which is approximately the average value given by the Bureau of Statistics for the year 1907, as reported in the Yearbook of the Department of Agriculture for that year.

TABULATION OF RESULTS.

The following table gives a complete summary of the results of the fertilizer tests on cotton soils. The first column of figures indicates the number of experiments which have been reported, with each substance tried. The actual experiment was usually performed on one-twentieth or one-tenth acre plats, but the results are uniformly stated in pounds per acre, both in case of fertilizers applied and in crop returns, and this unit is retained in this bulletin. The second column of figures shows the relative number of increases to no increase reported from the use of the several fertilizers. With nitrate of soda, for example, the chances based upon the 73 trials which have been reported are 3.5 to 1 that there will be an increase of cotton attending its use alone, while the chances based upon 559 trials are 4 to 1 that an increased crop will result.

The third column of figures shows the extreme range of effectiveness of the several fertilizers within the limit of the observations which have been made. With nitrate of soda there has been at least one case where the yield was 66 pounds less per acre

than the unfertilized plat and at least one case where the yield was 492 pounds more. The sixth column gives the average increase or decrease in pounds per acre attributable to the fertilizers used. This information, together with the average amount of fertilizer used per acre and its cost and the value of the increased cotton production, gives the basis for calculating the average gain or loss in money value, except that in no case has any allowance been made of the cost of applying the fertilizers to the land.

Results of fertilizer tests with cotton soils.

MINERALS SINGLY.

Kind of fertilizer used.	Total area.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Average crop increase per acre.		Average gain per acre.
				Used.	Cost.			
	<i>Acres.</i>	<i>Ratio.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Dollars.</i>	<i>Pounds.</i>	<i>Dollars.</i>	<i>Dollars.</i>
Nitrate of soda.....	73	3.5 : 1	— 60 to 492	160	4.00	64.0	6.40	2.40
Sulphate of ammonia.....	17	4.7 : 1	— 82 to 234	128	3.97	58.2	5.82	1.85
Acid phosphate.....	181	9.6 : 1	—108 to 363	286	1.90	69.8	6.98	5.08
Ground bone.....	14	13.0 : 1	—235 to 283	279	3.63	92.8	9.28	5.65
Rock phosphate.....	6	1.0 : 1	— 70 to 50	766	3.18	— 4.0	— .40	— 3.58
Floats.....	25	1.6 : 1	— 96 to 89	201	.80	16.7	1.67	.80
Basic slag.....	4	.3 : 1	— 48 to 104	230	1.42	— 1.0	— .10	1.52
Boneblack.....	3	3.0 : 0	— 20 to 290	500	5.50	132.7	13.27	7.77
Muriate of potash.....	36	3.0 : 1	— 27 to 180	98	2.16	34.5	3.45	1.29
Sulphate of potash.....	6	.5 : 1	— 30 to 149	112	3.36	21.2	2.12	— 1.24
Kainit.....	161	3.9 : 1	—108 to 201	292	1.75	32.3	3.23	1.48
Wood ashes.....	3	2.0 : 1	— 18 to 206	1,667	4.17	68.0	6.80	2.63
Cotton-seed-hull ashes.....	12	1.0 : 1	— 47 to 250	271	4.61	41.6	4.16	— .45
Lime.....	3	2.0 : 1	— 42 to 127	1,333	4.00	33.3	3.33	.67
Marl.....	3	2.0 : 1	— 20 to 64	900	.23	19.0	1.90	1.67
Gypsum.....	11	10.0 : 1	— 27 to 360	195	.78	197.4	19.74	18.96
Salt.....	1		— 8	200	.80	— 8.0	— .08	— .88
Total.....	559	4.1 : 1			2.33	54.0	5.40	3.07

MIXTURES OF TWO MINERALS.

Nitrate of soda.....	38	17.5 : 1	—30 to 360	180	6.06	109.6	10.96	4.90
Acid phosphate.....				223				
Nitrate of soda.....	12	12.0 : 0	8 to 96	125	3.95	53.6	5.36	1.41
Floats.....				203				
Nitrate of soda.....	13	6.0 : 1	—39 to 121	255	8.40	58.7	5.87	—2.53
Muriate of potash.....				92				
Nitrate of soda.....	18	17.0 : 1	—5 to 207	160	5.48	104.6	10.46	4.98
Kainit.....				244				
Sulphate of ammonia.....	2	2.0 : 0	27 to 30	90	4.16	28.5	2.85	—1.31
Acid phosphate.....				195				
Sulphate of ammonia.....	2	0 : 2	—23 to —19	90	3.99	—21.0	—2.10	—6.09
Floats.....				300				
Sulphate of ammonia.....	2	0 : 2	— 2 to 0	90	3.69	— 1.0	—0.10	—3.79
Kainit.....				150				
Acid phosphate.....	36	35.0 : 1	—40 to 353	174	2.95	102.7	10.27	7.32
Muriate of potash.....				79				
Acid phosphate.....	155	11.0 : 1	—61 to 366	235	2.84	77.3	7.73	4.89
Kainit.....				176				
Rock phosphate.....	2	0 : 2	—18 to —16	300	3.15	—17.0	—1.70	—4.85
Kainit.....				300				
Total.....	280	10.2 : 1			3.73	82.5	8.25	4.52

Results of fertilizer tests with cotton soils—Continued.

MIXTURES OF THREE OR MORE MINERALS.

Kind of fertilizer used.	Total area.	Increase to no increase.*	Range of crop increase.	Fertilizers per acre.		Average crop increase per acre.		Average gain per acre.
				Used.	Cost.			
	<i>Acres.</i>	<i>Ratio.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Dollars.</i>	<i>Pounds.</i>	<i>Dollars.</i>	<i>Dollars.</i>
Nitrate of soda.....	199	198.0 : 1	-11 to 457	232	9.48	159.3	15.93	6.45
Acid phosphate.....				280				
Muriate of potash.....				79				
Nitrate of soda.....	6	6.0 : 0	108 to 253	330	12.29	177.8	17.78	5.49
Acid phosphate.....				160				
Sulphate of potash.....				98				
Nitrate of soda.....	51	50.0 : 1	-18 to 512	264	9.50	222.9	22.29	12.79
Acid phosphate.....				283				
Kainit.....				226				
Nitrate of soda.....	3	3.0 : 0	25 to 41	130	6.93	33.0	3.30	-3.63
Rock phosphate.....				641				
Muriate of potash.....				36				
Nitrate of soda.....	5	5.0 : 0	37 to 113	330	10.77	75.8	7.58	-3.19
Floats.....				80				
Muriate of potash.....				100				
Nitrate of soda.....	6	6.0 : 0	32 to 75	330	11.02	53.3	5.33	-5.69
Basic slag.....				90				
Muriate of potash.....				100				
Sulphate of ammonia.....	19	19.0 : 0	68 to 376	109	6.98	202.8	20.28	13.30
Acid phosphate.....				187				
Muriate of potash.....				105				
Sulphate of ammonia.....	8	8.0 : 0	12 to 432	132	6.50	240.3	24.03	18.53
Acid phosphate.....				198				
Kainit.....				168				
Acid phosphate.....	1	1.0 : 0	.. to 149	160	3.38	149.0	14.90	11.52
Muriate of potash.....				100				
Marl.....				220				
Nitrate of soda.....	6	6.0 : 0	48 to 286	330	13.02	139.7	13.97	0.95
Acid phosphate.....				163				
Muriate of potash.....				117				
Marl.....	6	6.0 : 0	102 to 182	138	16.82	143.1	14.31	-2.46
Nitrate of soda.....				330				
Acid phosphate.....				160				
Muriate of potash.....	1	1.0 : 0	160	100	18.80	160.0	16.00	-2.80
Copperas.....				100				
Marl.....				900				
	311	154.5 : 1			9.53	169.4	16.94	7.41

ORGANIC FERTILIZERS SINGLY.

Cotton seed.....	35	4.9 : 1	-80 to 239	804	6.43	54.7	5.47	-0.96
Cotton-seed meal.....	161	7.4 : 1	-98 to 458	351	4.54	72.2	7.22	2.68
Dried blood.....	10	4.0 : 1	-88 to 143	146	2.92	39.3	3.93	1.01
Fish scrap.....	1	1.0 : 0	151	360	7.20	151.0	15.10	7.90
Leather scrap.....	1	1.0 : 0	48	360		48.0	4.80	
Tankage.....	1	1.0 : 0	161	150	1.50	161.0	16.10	14.10
	209	6.6 : 1			4.67	72.0	7.20	2.53

ORGANIC FERTILIZERS AND ONE MINERAL.

Cotton seed.....	21	21.0 : 0	60 to 587	1,004	9.68	205.4	20.54	10.86
Acid phosphate.....				236				
Cotton seed.....	10	10.0 : 0	19 to 184	1,888	16.86	108.7	10.87	-5.99
Muriate of potash.....				80				
Cotton seed.....	3	3.0 : 0	19 to 113	1,080	9.07	78.0	7.80	-1.27
Kainit.....				217				
Cotton-seed meal.....	5	4.0 : 1	-32 to 197	100	2.38	67.0	6.70	4.32
Nitrate of soda.....				45				
Cotton-seed meal.....	243	33.8 : 1	-22 to 362	216	4.19	108.2	10.82	6.63
Acid phosphate.....				213				

Results of fertilizer tests with cotton soils—Continued.

ORGANIC FERTILIZERS AND ONE MINERAL—Continued.

Kind of fertilizer used.	Total area.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Average crop increase per acre.		Average gain per acre.
				Used.	Cost.			
	Acres.	Ratio.	Pounds.	Pounds.	Dollars.	Pounds.	Dollars.	Dollars.
Cotton-seed meal.....	5	5.0 : 0	25 to 87	{ 180 474 }	3.60	51.0	5.10	1.50
Rock phosphate.....								
Cotton-seed meal.....	20	20.0 : 0	14 to 142	{ 169 208 }	2.76	65.1	6.51	3.75
Floats.....								
Cotton-seed meal.....	4	1.0 : 1	— 52 to 245	{ 133 220 }	3.03	53.0	5.30	2.27
Basic slag.....								
Cotton-seed meal.....	13	1.3 : 1	—102 to 153	{ 276 80 }	5.18	47.7	4.77	—0.41
Muriate of potash.....								
Cotton-seed meal.....	125	41.7 : 1	—131 to 551	{ 253 192 }	4.31	113.3	11.33	7.02
Kainit.....								
Cotton-seed meal.....	8	8.0 : 1	26 to 247	{ 347 360 }	10.46	130.6	13.06	2.60
Cotton-seed hull ashes.....								
Cotton-seed meal.....	8	8.0 : 0	26 to 247	{ 347 360 }	10.46	130.6	13.06	2.60
Cotton-seed hull ashes.....								
Cotton-seed meal.....	5	5.0 : 0	17 to 64	{ 151 1,628 }	5.55	187.6	18.76	13.21
Cotton-seed hulls.....								
Cotton-seed meal.....	1	1.0 : 0	47	{ 100 500 }	2.50	47.0	4.70	2.20
N. J. Greensand marl.....								
Tankage.....	3	3.0 : 0	120 to 260	{ 148 45 }	2.48	177.7	17.77	14.29
Muriate of potash.....								
	469	23.7 : 1	4.81	109.4	10.94	6.13

ORGANIC FERTILIZERS WITH TWO OR MORE MINERALS.

Cotton seed.....	6	6.0 : 0	42 to 276	{ 605 124 77 }	7.40	155.7	15.57	8.17
Acid phosphate.....								
Muriate of potash.....								
Cotton seed.....	33	33.0 : 0	37 to 354	{ 1,088 233 183 }	11.43	154.6	15.46	4.03
Acid phosphate.....								
Kainit.....								
Cotton seed.....	10	10.0 : 0	121 to 288	{ 2,240 320 200 }	23.56	201.6	20.16	—3.40
Acid phosphate.....								
Cotton-seed hull ashes.....								
Cotton-seed meal.....	6	6.0 : 0	21 to 417	{ 140 73 280 }	5.21	252.2	25.22	20.01
Nitrate of potash.....								
Acid phosphate.....								
Cotton-seed meal.....	6	5.0 : 1	0 to 189	{ 129 47 358 }	5.30	89.5	8.95	3.65
Nitrate of soda.....								
Acid phosphate.....								
Cotton-seed meal.....	1	1.0 : 0	.. to 205	{ 100 50 200 }	3.70	205.0	20.50	16.80
Nitrate of soda.....								
Kainit.....								
Cotton-seed meal.....	151	151.0 : 0	6 to 385	{ 302 367 54 }	7.52	136.5	13.65	6.13
Acid phosphate.....								
Muriate of potash.....								
Cotton-seed meal.....	27	26.0 : 1	— 79 to 324	{ 379 358 108 }	10.45	142.1	14.21	3.76
Acid phosphate.....								
Sulphate of potash.....								
Cotton-seed meal.....	285	39.7 : 1	—153 to 604	{ 224 217 149 }	5.22	143.4	14.34	9.12
Acid phosphate.....								
Kainit.....								
Cotton-seed meal.....	8	8.0 : 0	73 to 233	{ 482 266 213 }	11.51	148.9	14.89	3.48
Acid phosphate.....								
Cotton-seed hull ashes.....								
Cotton-seed meal.....	2	2.0 : 0	13 to 213	{ 400 300 2,000 }	9.60	113.0	11.30	1.70
Acid phosphate.....								
Wood ashes.....								
Cotton-seed meal.....	1	1.0 : 0	.. to 69	{ 486 243 194 }	7.77	69.0	6.90	—0.87
Acid phosphate.....								
Silicate of potash.....								
Cotton-seed meal.....	1	1.0 : 0	.. to 132	{ 84 414 }	4.95	132.0	13.20	8.25
Acid phosphate.....								
Lime.....								

Results of fertilizer tests with cotton soils—Continued.

ORGANIC FERTILIZERS WITH TWO OR MORE MINERALS—Continued.

Kind of fertilizer used.	Total area.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Average crop increase per acre.		Average gain per acre.
				Used.	Cost.			
	<i>Acres.</i>	<i>Ratio.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Dollars.</i>	<i>Pounds.</i>	<i>Dollars.</i>	<i>Dollars.</i>
Cotton-seed meal.....	1	1.0 : 0	.. to 16	132	2.50	16.0	1.60	-0.90
Acid phosphate.....				121				
Oyster shells.....				1,000				
Cotton-seed meal.....	24	11.0 : 1	- 12 to 133	146	8.26	63.7	6.37	-1.89
Ground bone.....				406				
Muriate of potash.....				52				
Cotton-seed meal.....	14	14.0 : 0	113 to 604	416	10.11	248.7	24.87	14.76
Ground bone.....				292				
Kainit.....				185				
Cotton-seed meal.....	2	2.0 : 0	62 to 88	125	2.12	75.0	7.50	4.38
Rock phosphate.....				125				
Kainit.....				100				
Cotton-seed meal.....	3	0.5 : 1	- 32 to 28	300	2.31	-5.3	- 0.53	-2.84
Floats.....				300				
Muriate of potash.....				90				
Cotton-seed meal.....	11	11.0 : 0	16 to 170	372	5.76	74.8	7.48	1.72
Floats.....				240				
Kainit.....				114				
Cotton-seed meal.....	8	1.7 : 1	- 37 to 70	278	5.85	22.4	2.24	-3.61
Basic slag.....				270				
Kainit.....				115				
Cotton-seed meal.....	5	0.7 : 1	- 32 to 40	292	6.31	-2.0	- 0.20	-6.51
Muriate of potash.....				88				
Gypsum.....				184				
Cotton-seed meal.....	4	4.0 : 0	158 to 272	260	6.17	233.0	23.30	17.13
Kainit.....				347				
Gypsum.....				210				
Dried blood.....	33	33.0 : 0	54 to 348	224	8.17	154.7	15.47	7.30
Acid phosphate.....				241				
Muriate of potash.....				64				
Dried blood.....	8	8.0 : 0	141 to 325	223	7.30	251.0	25.10	17.80
Acid phosphate.....				220				
Kainit.....				218				
Fish scrap.....	5	5.0 : 0	98 to 240	138	5.48	166.0	16.60	11.12
Acid phosphate.....				196				
Muriate of potash.....				60				
Fish scrap.....	6	6.0 : 0	147 to 373	240	9.63	268.0	26.80	17.17
Acid phosphate.....								
Kainit.....								
Cotton-seed meal.....	54	27.0 : 1	- 44 to 308	182	7.11	99.3	9.93	2.82
Nitrate of soda.....				53				
Acid phosphate.....				378				
Muriate of potash.....	7	7.0 : 0	104 to 158	43	12.98	119.0	11.90	-1.08
Cotton-seed meal.....				208				
Nitrate of soda.....				36				
Acid phosphate.....	1	1.0 : 0	... to 254	468	5.10	254.0	25.40	20.30
Sulphate of potash.....				98				
Cotton-seed meal.....				100				
Nitrate of soda.....	3	3.0 : 0	132 to 206	50	5.20	171.0	17.10	12.90
Acid phosphate.....				200				
Kainit.....				200				
Cotton-seed meal.....	1	1.0 : 0	... to 92	145	2.84	92.0	9.20	6.36
Acid phosphate.....				580				
Kainit.....				272				
Oyster shells.....	3	3.0 : 0	140 to 188	30	4.55	158.0	15.80	11.25
Cotton-seed meal.....				132				
Nitrate of soda.....				121				
Sulphate of ammonia.....	1	1.0 : 0	... to 92	56	2.84	92.0	9.20	6.36
Acid phosphate.....				1,000				
Muriate of potash.....								
Cotton-seed meal.....	3	3.0 : 0	140 to 188	42	4.55	158.0	15.80	11.25
Nitrate of soda.....				50				
Sulphate of ammonia.....				26				
Acid phosphate.....	1	1.0 : 0	... to 92	140	2.84	92.0	9.20	6.36
Muriate of potash.....				45				
	730	33.8 : 1			7.13	130.3	13.03	5.90

Results of fertilizer tests with cotton soils—Continued.

MANURE AND COMPOSTS.

Kind of fertilizer used.	Total area.	Increase to no increase.	Range of crop increase.	Fertilizers per acre.		Average crop increase per acre.	Average gain per acre.
				Used.	Cost.		
	<i>Acres.</i>	<i>Ratio.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Dollars.</i>	<i>Pounds.</i>	<i>Dollars.</i>
Manure.....	100	32.3 : 1	— 33 to 340	24,104	6.03	146.9	14.69
Manure.....	2	2.0 : 0	2 to 239	{ 4,000	1.20	120	12.00
Acid phosphate.....				{ 200			
Manure.....	1	1.0 : 0	.. to 50	{ 1,000	1.30	50	5.00
Gypsum.....				{ 200			
Manure.....	3	3.0 : 0	123 to 413	{ 42,000	6.52	247.3	24.73
Acid phosphate.....				{ 168			
Muriate of potash.....	2	2.0 : 0	184 to 234	{ 84	1.33	209	20.90
Manure.....				{ 2,960			
Acid phosphate.....	4	4.0 : 0	138 to 255	{ 192	1.77	182.7	18.27
Muriate of potash.....				{ 99			
Manure.....	2	2.0 : 0	154 to 154	{ 6,000	4.12	154	15.40
Nitrate of soda.....				{ 160			
Acid phosphate.....	2	2.0 : 0	194 to 194	{ 70	2.42	194	19.40
Muriate of potash.....				{ 50			
Manure.....	2	2.0 : 0	78 to 78	{ 500	2.29	78	7.80
Cotton seed.....				{ 500			
Manure.....	2	2.0 : 0	194 to 194	{ 375	2.71	177.6	17.76
Cotton seed.....				{ 375			
Acid phosphate.....	2	2.0 : 0	78 to 78	{ 250	2.29	78	7.80
Manure.....				{ 375			
Cotton seed.....	11	10.0 : 1	— 80 to 256	{ 375	.97	99.6	9.96
Kainit.....				{ 250			
Cow manure.....	10	10.0 : 0	132 to 254	{ 3,890	2.71	177.6	17.76
Cow manure.....				{ 3,553			
Acid phosphate.....	65	31.5 : 1	— 33 to 384	{ 261	.46	123	12.30
Compost.....				{ 1,888			
	204	33.0 : 1			3.53	140.1	14.01

PEA VINES AND STOVER.

Cowpea vines.....	7	7.0 : 0	40 to 154			87.7	8.77
Corn stover.....	1	1.0 : 0	.. to ..			16	1.60

COMMERCIAL FERTILIZERS.

Commercial fertilizers a.....	32	32.0 : 0	9 to 720	636	6.36	112.5	11.25	4.89
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SUMMARY.

Minerals alone.....	559	4.1 : 1			2.33	54	5.40	3.07
Minerals in combinations of two.....	280	10.2 : 1			3.73	82.5	8.25	4.52
Minerals in combinations of three or more.....	311	154.5 : 1			9.53	169.4	16.94	7.41
Organic fertilizers alone.....	209	7.0 : 1			4.69	72	7.20	2.53
Organic fertilizers in combination with one mineral.....	409	23.7 : 1			4.81	109.4	10.94	6.13
Organic fertilizers in combination with two or more minerals.....	730	33.8 : 1			7.13	130.3	13.03	5.90
Manure alone and with minerals and compost.....	204	33.0 : 1			3.53	140.1	14.01	10.48
Commercial fertilizers.....	32	32.0 : 0			6.36	112.5	11.25	4.89

a Composition not stated.

From the summary it appears that with two or three substances combined the chances for success are increased. For minerals the ratio of the number of cases of reported increase to no increase is 4.1, 10.2, and 154.5 to 1, accordingly as one, two, or three or more substances are used, while the corresponding increases in crop are 54, 82.5, and 169.4 pounds per acre, respectively. The average gain likewise increases, as shown by the figures in the last column—\$3.07, \$4.52, and \$7.41, respectively.

With the organic fertilizers, such as cotton seed, cotton-seed meal, dried blood, tankage, and fish scrap, the chances to obtain an increase are greater when one or two minerals are added, as shown by the ratio 7, 23.7, and 33.8 to 1, and by the increase in yield of 72, 109, and 130 pounds per acre. In this case, however, the increased cost of the mixtures actually used makes the mixture of two or more of the mineral substances with the organic fertilizers slightly less profitable than when a single mineral is used in the mixture.

On the whole, manure and compost have shown up very well where these can be obtained as cheaply as the cost ascribed to them. The actual value of manure or cost to the farmer is so indefinite that too much importance should not be given to the high average gain in value shown in the table. All recorded cases of the use of commercial fertilizers have shown an increase in crop production giving a net gain of about \$5 per acre at an estimated cost of \$20 per ton for the fertilizer used.

The actual number of cases in each class of fertilizer used showing an increase in production and no increase are given in the following table:

Actual number of increases and no increases reported with each class of fertilizer.

Fertilizer.	Acres.	Increase.	No increase.	Ratio.
Minerals alone.....	559	450	109	4.1 : 1
Minerals in combinations of two.....	280	255	25	10.2 : 1
Minerals in combinations of three or more.....	311	309	2	154.5 : 1
Organic fertilizers alone.....	209	183	26	7.0 : 1
Organic fertilizers in combination with one mineral.....	469	450	19	23.7 : 1
Organic fertilizers in combination with two or more minerals.....	730	709	21	33.8 : 1
Manure alone and with minerals, compost, pea vines, and corn stover.....	212	206	6	34.5 : 1
Commercial fertilizers.....	32	32	0	32.0 : 0
Total.....	2,802	2,594	208	12.5 : 1

EFFECTIVENESS OF SINGLE SUBSTANCES AND MIXTURES.

Notwithstanding what has been said about the wide variations of "check" plats and the wide range in crop increases with all the fertilizers, these general conclusions that the chances for increased yields increase with the number of substances used in the mixture, at least up to three substances, seem so consistent and regular that there can be little doubt of their correctness.

To examine further this point several of the single fertilizers and their combinations have been brought together in the following table, showing both the sum of the increases attributable to the single fertilizers and the increases due to the combination of two or three substances:

Increase in yield of lint cotton per acre, due to single fertilizers, compared with increase due to mixtures of these fertilizers.

Fertilizers.		Number of experiments.	Increase per acre.
			Pounds.
(a)	Nitrate of soda.....	73	64
	Acid phosphate.....	181	69.8
	Mixture.....	36	133.8 109.6
(b)	Nitrate of soda.....	73	64
	Muriate of potash.....	36	34.5
	Mixture.....	13	98.5 58.7
(c)	Nitrate of soda.....	73	64
	Kainit.....	161	32.3
	Mixture.....	18	96.3 104.6
(d)	Acid phosphate.....	181	69.8
	Muriate of potash.....	36	34.5
	Mixture.....	36	104.3 102.7
(e)	Acid phosphate.....	181	69.8
	Kainit.....	161	32.3
	Mixture.....	155	102.1 77.3
(f)	Nitrate of soda.....	73	64
	Acid phosphate.....	181	69.8
	Muriate of potash.....	36	34.5
(g)	Mixture.....	199	168.3 159.3
	Nitrate of soda.....	73	64
	Acid phosphate.....	181	69.8
(h)	Kainit.....	161	32.3
	Mixture.....	51	166.1 222.9
	Cotton seed.....	35	54.7
(h)	Acid phosphate.....	181	69.8
	Mixture.....	21	124.5 202.4

Increase in yield of lint cotton per acre, due to single fertilizers, compared with increase due to mixtures of these fertilizers—Continued.

Fertilizers.		Number of experi- ments.	Increase per acre.
			<i>Pounds.</i>
(i)	Cotton seed.....	35	54.7
	Muriate of potash.....	36	34.5
	Mixture.....	10	89.2 108.7
(j)	Cotton seed.....	35	54.7
	Kainit.....	161	42.3
	Mixture.....	3	87.0 78.0
(k)	Cotton seed.....	35	54.7
	Acid phosphate.....	181	69.8
	Muriate of potash.....	36	34.5
	Mixture.....	6	159.0 155.7
(l)	Cotton seed.....	35	54.7
	Acid phosphate.....	181	69.8
	Kainit.....	161	32.3
	Mixture.....	33	156.8 154.6
(m)	Cotton-seed meal.....	161	54.7
	Acid phosphate.....	181	69.8
	Mixture.....	243	124.5 108.2
(n)	Cotton-seed meal.....	161	54.7
	Muriate of potash.....	36	34.5
	Mixture.....	13	89.2 47.7
(o)	Cotton-seed meal.....	161	54.7
	Kainit.....	161	32.3
	Mixture.....	128	87.0 113.3
(p)	Cotton-seed meal.....	161	54.7
	Acid phosphate.....	181	69.8
	Muriate of potash.....	36	34.5
	Mixture.....	151	159.0 136.5
(q)	Cotton-seed meal.....	161	54.7
	Acid phosphate.....	181	69.8
	Kainit.....	161	32.3
	Mixture.....	285	156.8 143.3

It will be observed that the data contained in this table embrace all observations which have been reported on all soils and in all seasons, both from the single substances and for the several mixtures. There is, on the whole, an apparent tendency toward an additive effect, each substance in the mixture having its own effect as it would have were the other substances not present. Whether and to what extent each substance may modify the effect of another or be modified by it can not be determined from the data.

The accompanying diagram (fig. 1) illustrates this fact. The letters at the bottom of the diagram refer to the fertilizers in the preceding table, the solid line representing mixed fertilizers and the broken line representing the sum of the individual constituents of the mixtures when used separately.

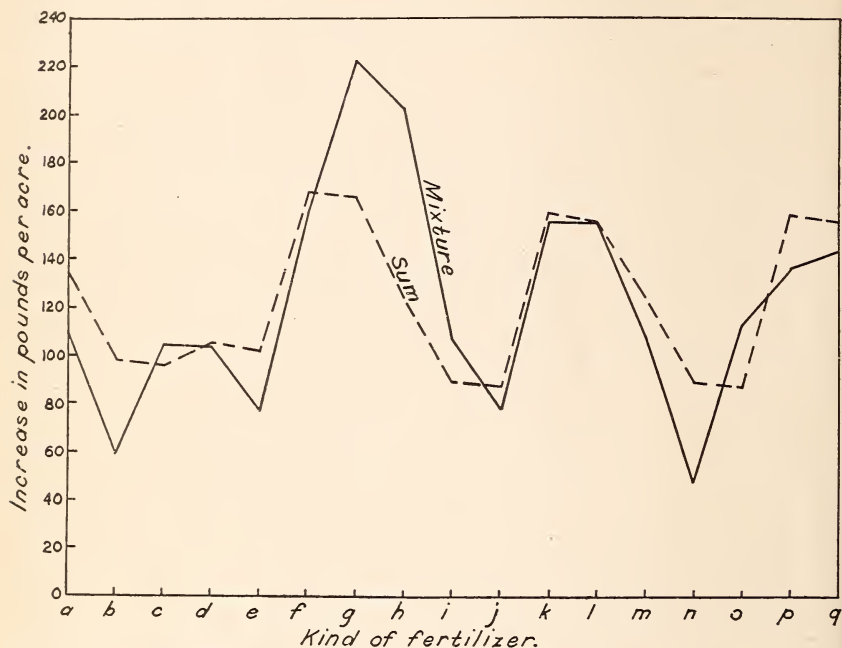


FIG. 1.—Curves showing the relative effect of fertilizer mixtures and the sum of the effect of each ingredient of the mixture used separately.

EFFECT OF USING INCREASED AMOUNTS OF FERTILIZER.

The following table contains all the data available to determine the effect of increasing the amount of fertilizer applied to the soil. All experiments on any soil and in any year when the amount of nitrate of soda applied, for example, is between 40 and 74 pounds per acre are summed up and weighted averages obtained. The number of experiments is given in each case with the absolute range of crop increase.

Increase in yield of lint cotton attributable to different amounts of fertilizers.

Name of fertilizer.	Quantity per acre.	Number of experiments.	Range of crop increase.	Average increase per acre.
	<i>Pounds.</i>		<i>Pounds.</i>	<i>Pounds.</i>
Nitrate of soda.....	40 to 74	4	21 to 112	57
	75 to 99	19	— 66 to 224	50
	100 to 149	18	— 21 to 209	37
	150 to 199	10	— 13 to 458	134
	200 to 350	22	— 43 to 492	68
Sulphate of ammonia.....	40 to 74	6	— 63 to 64	16
	75 to 99	3	23 to 105	56
	100 to 149	5	12 to 234	137
	150 to 199	0	—	—
	200+	3	— 82 to 22	— 96
Acid phosphate.....	100 to 149	9	0 to 173	77
	150 to 199	34	— 79 to 363	110
	200 to 299	45	— 21 to 326	83
	300 to 399	44	— 30 to 151	40
	400 to 499	42	— 108 to 179	53
	500+	7	2 to 260	115
Ground bone.....	150 to 199	6	39 to 283	133
	200 to 299	2	— 235 to 116	— 119
	300 to 399	1	3	3
	400 to 499	3	20 to 230	—
	500+	2	12 to 283	148
Floats.....	150 to 199	10	— 77 to 83	11
	200 to 299	12	— 56 to 89	27
	300 to 399	3	— 96 to 64	— 7
Muriate of potash.....	40 to 79	3	— 27 to 131	54
	80 to 99	11	— 25 to 120	17
	100 to 149	6	21 to 44	31
	150 to 199	2	16 to 20	18
	200 to 300	4	— 18 to 180	44
Kainit.....	100 to 149	18	— 108 to 69	5
	150 to 199	14	— 53 to 107	37
	200 to 299	39	— 108 to 133	54
	300 to 399	44	— 101 to 119	29
	400 to 499	40	— 88 to 96	31
	500+	6	— 56 to 78	13
Cotton seed.....	100 to 299	3	0 to 100	34
	300 to 499	8	— 80 to 48	— 22
	500 to 699	4	10 to 139	52
	700 to 999	4	12 to 105	60
	1,000 to 1,499	13	32 to 269	105
	1,500+	3	35 to 112	77
Cotton-seed meal.....	100 to 199	19	— 80 to 198	60
	200 to 299	46	— 81 to 255	52
	300 to 399	17	— 16 to 458	104
	400 to 499	42	— 98 to 250	62
	500 to 599	32	— 28 to 304	93
	600 to 799	3	84 to 193	153
	800+	2	50 to 160	105
Manure.....	1,000 to 9,999	30	— 10 to 336	124
	10,000 to 19,999	4	171 to 258	199
	20,000 to 39,999	30	— 33 to 341	143
	40,000+	36	— 18 to 387	164
Compost.....	500 to 999	18	38 to 171	90
	1,000 to 1,499	9	0 to 248	119
	1,500 to 1,999	24	10 to 228	84
	2,000+	14	31 to 386	199
Commercial fertilizers.....	200 to 299	1	60	60
	300 to 399	5	9 to 243	106
	400 to 499	2	137 to 156	146
	500 to 599	14	25 to 720	116
	600 to 699	2	109 to 173	141
	700+	8	30 to 200	100

It will be observed that the results are quite irregular, as would be expected from the small number of experiments in some of the grades and by the wide range in crop increases. There is, on the whole, no indication of any consistent or regular increase in productivity with increasing amounts of fertilizer used. In most cases it would be unsafe to assume that the larger application of fertilizers would give larger increases than the smallest or next to the smallest application shown in the table.

RELATION OF FERTILIZER EFFECT AND NATURAL PRODUCTIVENESS
OF SOIL.

In order to determine, if possible, whether the effectiveness of the fertilizers is dependent in any marked way upon the natural productivity of the soil, all available data has been brought together in the following table. As an example of the use of the table, it is seen that there have been 19 cases where nitrate of soda (in varying amounts) has been applied to soils where the "check" or unfertilized plat has yielded at the same time from 50 to 99 pounds per acre. On these 19 plats the weighted average increase attributable to the nitrate of soda has been 29 pounds of lint cotton per acre.

Increase in yield of lint cotton attributable to fertilizers, arranged in accordance with the actual yield of the "check" plats.

Fertilizer.	Yield of unfertilized plats.	Number of experiments.	Range of increase.	Average increase.
	<i>Pounds.</i>		<i>Pounds.</i>	<i>Pounds.</i>
Nitrate of soda.....	Below 50			
	50 to 99	19	— 35 to 75	29
	100 to 149	5	— 43 to 180	40
	150 to 199	7	— 20 to 111	38
	200 to 249	14	— 66 to 492	107
	250 to 299	10	— 16 to 160	78
	300 to 349	9	0 to 224	67
	350 to 399	4	— 32 to 112	20
	400+	5	— 13 to 458	138
Sulphate of ammonia.....	Below 50			
	50 to 99	1	64	64
	100 to 149	2	55 to 105	80
	150 to 199	2	7 to 20	13
	200 to 249	8	— 82 to 234	39
	250 to 299	1	—22	— 22
	300 to 349	0		
	350 to 399	0		
	400+	3	22 to 195	85
Acid phosphate.....	Below 50			
	50 to 99	17	— 5 to 111	51
	100 to 149	39	— 8 to 166	55
	150 to 199	32	— 7 to 250	66
	200 to 249	24	—108 to 175	80
	250 to 299	31	— 70 to 337	73
	300 to 349	11	— 13 to 363	92
	350 to 399	16	9 to 326	124
	400+	11	— 79 to 252	59
Muriate of potash.....	Below 50			
	50 to 99	13	— 25 to 43	17
	100 to 149	4	12 to 180	78
	150 to 199	5	7 to 127	50
	200 to 249	6	— 19 to 3	— 10
	250 to 299	1	120	120
	300 to 349	3	6 to 31	89
	350 to 399	2	20 to 120	70
	400+	2	8 to 127	17

Increase in yield of lint cotton attributable to fertilizers, arranged in accordance with the actual yield of the "check" plats—Continued.

Fertilizer.	Yield of unfertilized plats.	Number of experiments.	Range of increase.	Average increase.
	<i>Pounds.</i>		<i>Pounds.</i>	<i>Pounds.</i>
Kainit.....	Below 50	18	— 25 to 128	18
	50 to 99	33	— 33 to 106	41
	100 to 149	31	— 19 to 133	43
	150 to 199	24	— 101 to 201	44
	200 to 249	27	— 65 to 93	23
	250 to 299	6	— 13 to 117	33
	300 to 349	13	— 108 to 106	45
	350 to 399	4	4 to 86	39
	400+	5	— 57 to 111	12
Nitrate of soda and acid phosphate.....	Below 50	3	— 5 to 141	86
	50 to 99	15	15 to 179	113
	100 to 149	5	— 30 to 115	41
	150 to 199	6	94 to 194	153
	200 to 249	2	82 to 88	85
	250 to 299	4	32 to 128	80
	300 to 349	2	212 to 360	286
	350 to 399			
	400+	1	72	72
Acid phosphate and muriate of potash.....	Below 50			
	50 to 99	12	51 to 229	114
	100 to 149	2	45 to 119	82
	150 to 199	5	49 to 127	92
	200 to 249	15	5 to 213	93
	250 to 299			
	300 to 349			
	350 to 399			
	400+	2	— 40 to 353	157
Acid phosphate and kainit.....	Below 50	21	10 to 128	66
	50 to 99	28	— 12 to 204	72
	100 to 149	25	3 to 157	70
	150 to 199	24	— 61 to 225	83
	200 to 249	31	— 59 to 212	52
	250 to 299	6	— 33 to 143	42
	300 to 349	5	13 to 236	119
	350 to 399	2	53 to 67	60
	400+	13	— 130 to 366	170
Nitrate of soda, acid phosphate, and muriate of potash.....	Below 50			
	50 to 99	73	59 to 457	193
	100 to 149	23	63 to 291	172
	150 to 199	3	108 to 176	143
	200 to 249	22	45 to 145	90
	250 to 299	7	50 to 206	121
	300 to 349	1	105	105
	350 to 399	10	85 to 150	113
	400+	60	— 32 to 305	151
Nitrate of soda, acid phosphate, and kainit.....	Below 50	3	107 to 171	144
	50 to 99	5	124 to 209	165
	100 to 149	9	107 to 279	199
	150 to 199	21	121 to 307	205
	200 to 249	5	— 18 to 512	275
	250 to 299			
	300 to 349	2	252 to 304	278
	350 to 399			
	400+	6	240 to 458	352
Cotton seed.....	Below 50			
	50 to 99	1	12	12
	100 to 149	3	32 to 233	100
	150 to 199	6	3 to 209	124
	200 to 249	16	156	60
	250 to 299			
	300 to 349	4	— 64 to 73	— 24
	350 to 399	3	— 80 to 80	— 21
	400+	2	44 to 71	58
Cotton-seed meal.....	Below 50	16	— 7 to 121	53
	50 to 99	25	— 28 to 126	59
	100 to 149	30	— 41 to 304	105
	150 to 199	24	— 98 to 160	52
	200 to 249	26	— 77 to 255	80
	250 to 299	9	— 80 to 123	41
	300 to 349	8	— 14 to 80	31
	350 to 399	2	— 48 to — 42	— 45
	400+	19	— 81 to 458	125

Increase in yield of lint cotton attributable to fertilizers, arranged in accordance with the actual yield of the "check" plats—Continued.

Fertilizer.	Yield of unfertilized plats.	Number of experiments.	Range of increase.	Average increase.
	<i>Pounds.</i>		<i>Pounds.</i>	<i>Pounds.</i>
Cotton-seed meal and acid phosphate.....	Below 50	26	21 to 254	110
	50 to 99	40	2 to 224	85
	100 to 149	41	— 20 to 226	89
	150 to 199	56	2 to 286	139
	200 to 249	38	34 to 270	118
	250 to 299	23	10 to 281	111
	300 to 349	13	— 4 to 362	80
	350 to 399			
	400+	6	— 21 to 223	89
Cotton-seed meal and kainit	Below 50	14	10 to 255	97
	50 to 99	22	9 to 194	77
	100 to 149	24	36 to 170	99
	150 to 199	18	—131 to 197	80
	200 to 249	22	5 to 451	138
	250 to 299	9	— 37 to 333	143
	300 to 349	10	6 to 316	126
	350 to 399	1		139
	400+	8	121 to 551	247
Cotton seed, acid phosphate, and kainit	Below 50			
	50 to 99			
	100 to 149	8	73 to 129	97
	150 to 199	3	129 to 155	143
	200 to 249	18	37 to 354	142
	250 to 299			
	300 to 349			
	350 to 399			
	400+	4	164 to 321	239
Cotton-seed meal, acid phosphate, and muriate of potash.	Below 50			
	50 to 99	3	237 to 335	293
	100 to 149	5	95 to 125	109
	150 to 199	5	141 to 172	157
	200 to 249	9	66 to 346	244
	250 to 299	25	75 to 189	113
	300 to 349	17	55 to 231	141
	350 to 399	8	57 to 120	82
	400+	42	23 to 230	119
Cotton-seed meal, acid phosphate, and kainit.....	Below 50	27	30 to 475	104
	50 to 99	46	13 to 208	100
	100 to 149	47	26 to 216	108
	150 to 199	37	— 34 to 238	128
	200 to 249	50	8 to 481	140
	250 to 299	22	24 to 573	186
	300 to 349	16	— 51 to 388	158
	350 to 399	8	40 to 163	96
	400+	39	—153 to 604	245
Cotton-seed meal, acid phosphate, and sulphate of potash	Below 50			
	50 to 99			
	100 to 149			
	150 to 199	7	5 to 280	163
	200 to 249	7	120 to 290	196
	250 to 299			
	300 to 349			
	350 to 399			
	400+	13	— 79 to 324	102
Dried blood, acid phosphate, and muriate of potash....	Below 50			
	50 to 99	5	230 to 348	299
	100 to 149	4	118 to 279	196
	150 to 199	2	98 to 108	103
	200 to 249	6	120 to 200	160
	250 to 299	3	108 to 154	120
	300 to 349			
	350 to 399			
	400+	13	54 to 154	98
Manure.....	Below 50	15	13 to 336	125
	50 to 99	34	10 to 386	167
	100 to 149	26	37 to 340	162
	150 to 199	5	36 to 179	81
	200 to 249	19	— 18 to 256	102
	250 to 299	3	157 to 293	227
	300 to 349	4	63 to 293	158
	350 to 399	3	— 80 to 213	98
	400+	2	— 33 to 190	79

Increase in yield of lint cotton attributable to fertilizers, arranged in accordance with the actual yield of the "check" plats—Continued.

Fertilizer.	Yield of unfertilized plats.	Number of experiments.	Range of increase.	Average increase.
	<i>Pounds.</i>		<i>Pounds.</i>	<i>Pounds.</i>
Compost.....	Below 50	4	58 to 146	99
	50 to 99	14	20 to 228	120
	100 to 149	12	33 to 226	93
	150 to 199	7	31 to 138	87
	200 to 249	17	386	182
	250 to 299			
	300 to 349	1	93	93
	350 to 399	10	10 to 104	47
	400+			
Commerical fertilizers.....	Below 50	3	35 to 82	51
	50 to 99	10	35 to 720	175
	100 to 149	5	36 to 243	98
	150 to 199			
	200 to 249	12	8 to 200	85
	250 to 299			
	300 to 349	1	13	13
	350 to 399	1	173	173
	400+			

While there is considerable irregularity in the results, as would be expected from the great differences in the range of increase, there is no indication of any consistent difference in the increase from the different classes of soils. The following table, which is a summary of the one just given, shows this more clearly, as from the greater number of cases averaged the results are more regular.

Average of 2,219 experiments with all kinds of fertilizers, arranged according to the increased yield of the unfertilized plats.

Yield of unfertilized plats.	Number of experiments.	Average increase.	Yield of unfertilized plats.	Number of experiments.	Average increase.
<i>Pounds.</i>			<i>Pounds.</i>		<i>Pounds.</i>
Below 50.....	167	81	250 to 299.....	140	126
50 to 99.....	438	107	300 to 349.....	125	107
100 to 149.....	343	100	350 to 399.....	58	68
150 to 199.....	291	107	400+.....	256	153
200 to 249.....	401	104			

It seems evident from the foregoing that the fertilizers have yielded about the same increase in crop on all classes of soils, basing the class in this case on the yield of the unfertilized plat.

SUMMARY.

It appears from the foregoing, that in the past twenty-one years the experiment stations have reported the results of 2,802 experiments with fertilizers on cotton soils. A large percentage of these were made from 1888 to 1893.

The duplicate "check" plats show such wide variations that considerable latitude must be allowed in the interpretation of all results, and the quantitative comparisons should not be given too great weight.

The chances for increase in crop production are greater with two or three fertilizers mixed than with a single substance, and the larger increase gives in general a larger financial gain.

The increase in yield due to mixtures of minerals approximates an additive effect, the increase due to the mixtures being approximately equal to the sum of the increases due to the individual fertilizers.

It appears that the smaller applications of single fertilizers, manure, compost, and commercial fertilizers have given in general no less an increase than the larger amounts. The increases obtained from the more productive soils, based upon the yield of the unfertilized plats, appear to be no less than from the less productive soils, indicating an equal increase in crop for the same quantity of fertilizers used for good soils as for less productive soils.

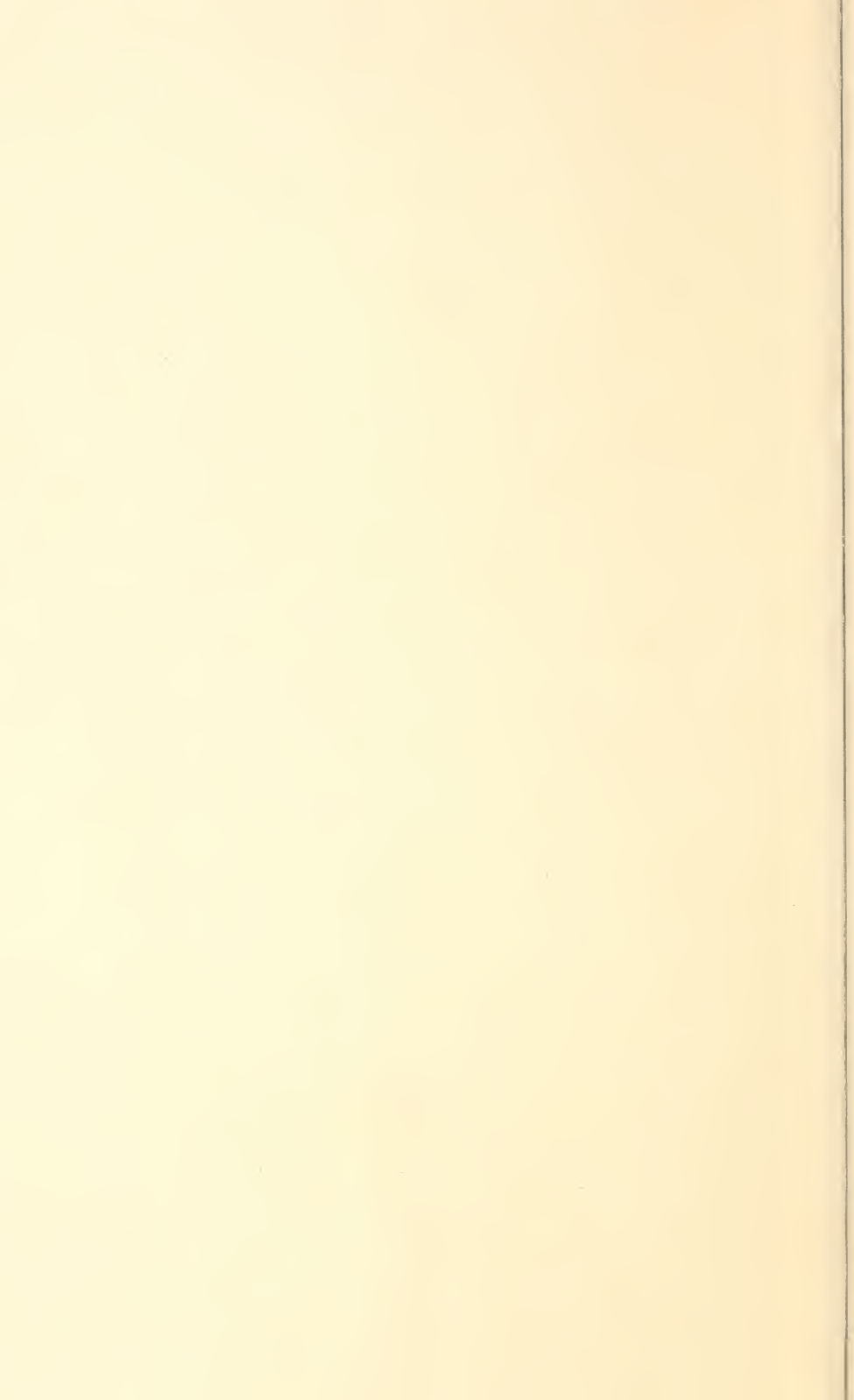
The data contained in the station reports do not permit one to judge of the cumulative effect of the continued use of fertilizers on the same soil for a long series of years.

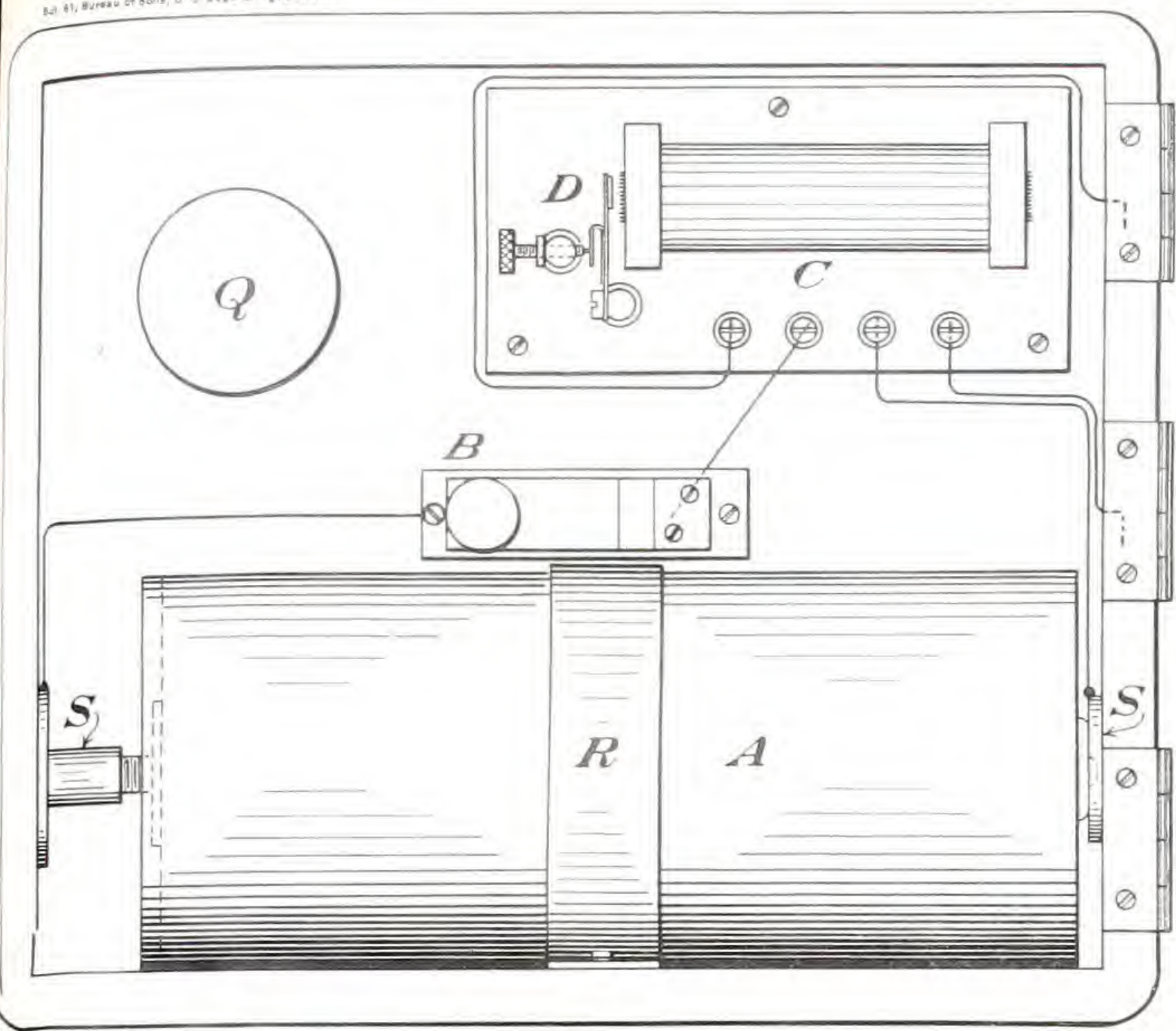
As these results have been obtained from a large number of soils, with a considerable range of productivity, over a number of years, these general conclusions, besides others of a qualitative value which can be drawn from the tables, can, in the absence of any more specific knowledge of any particular soil, be safely followed as a guide to the immediate selection of fertilizers for a cotton soil.

PLATE III.

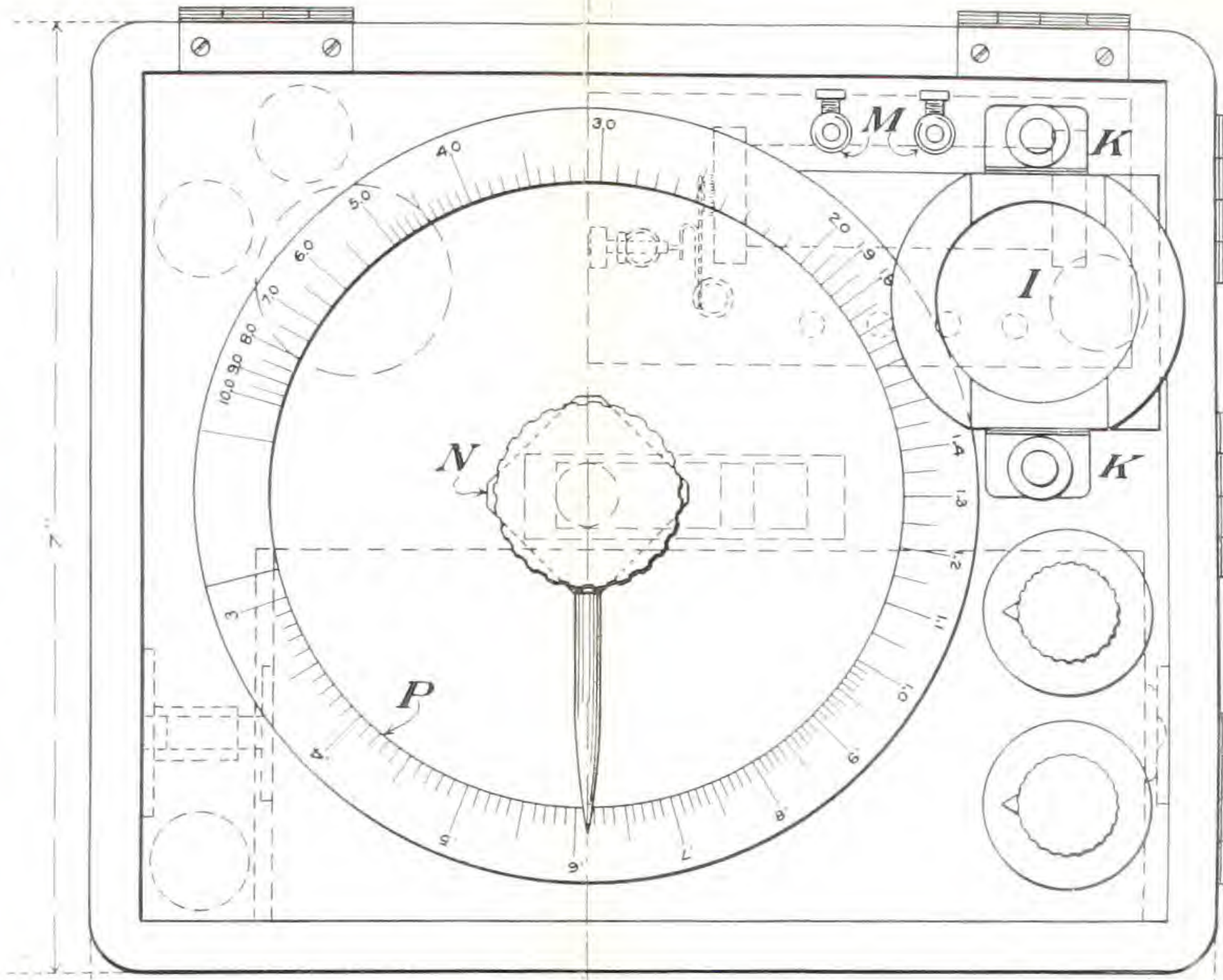
key
valve
8-10-1



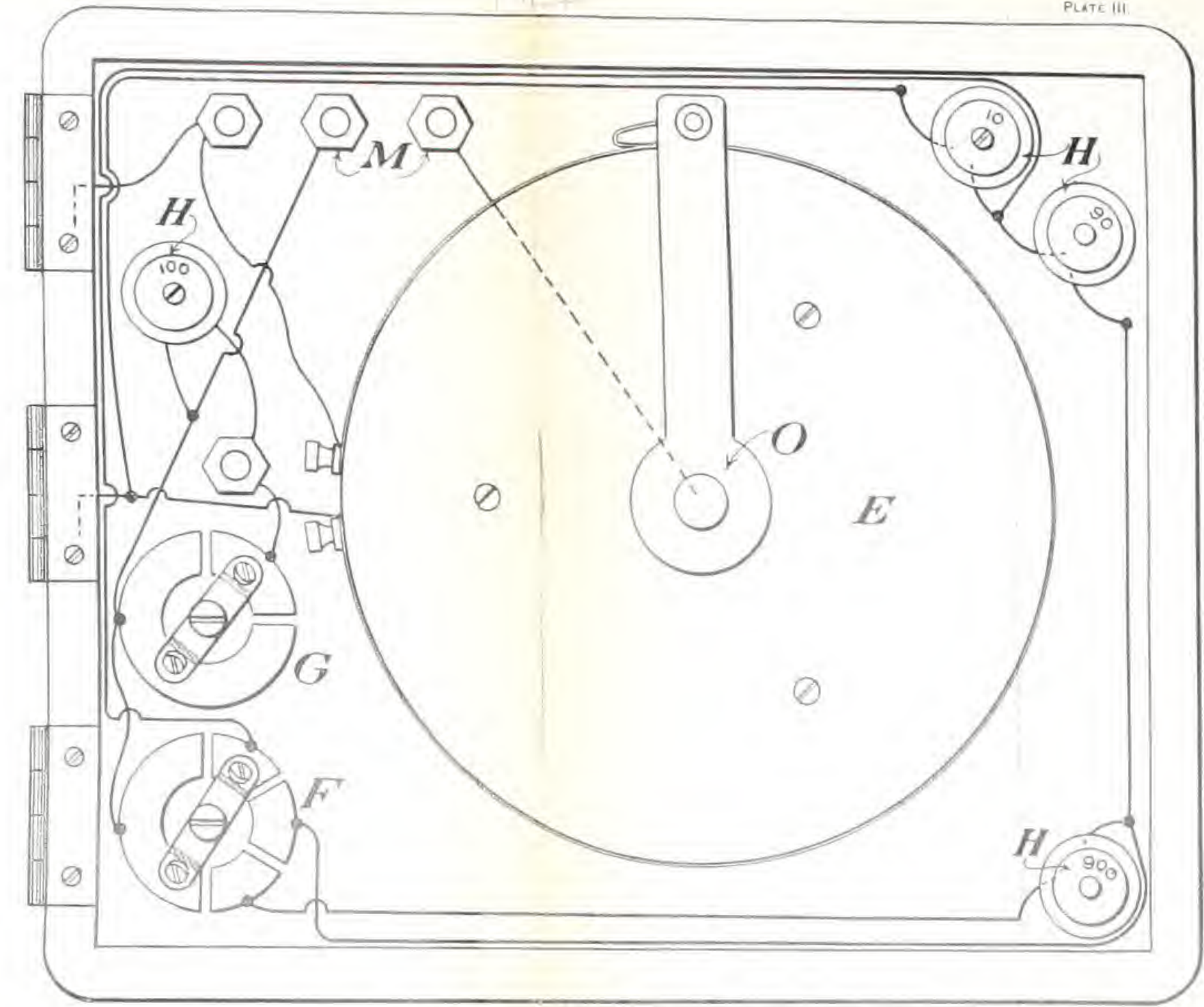




LOWER COMPARTMENT



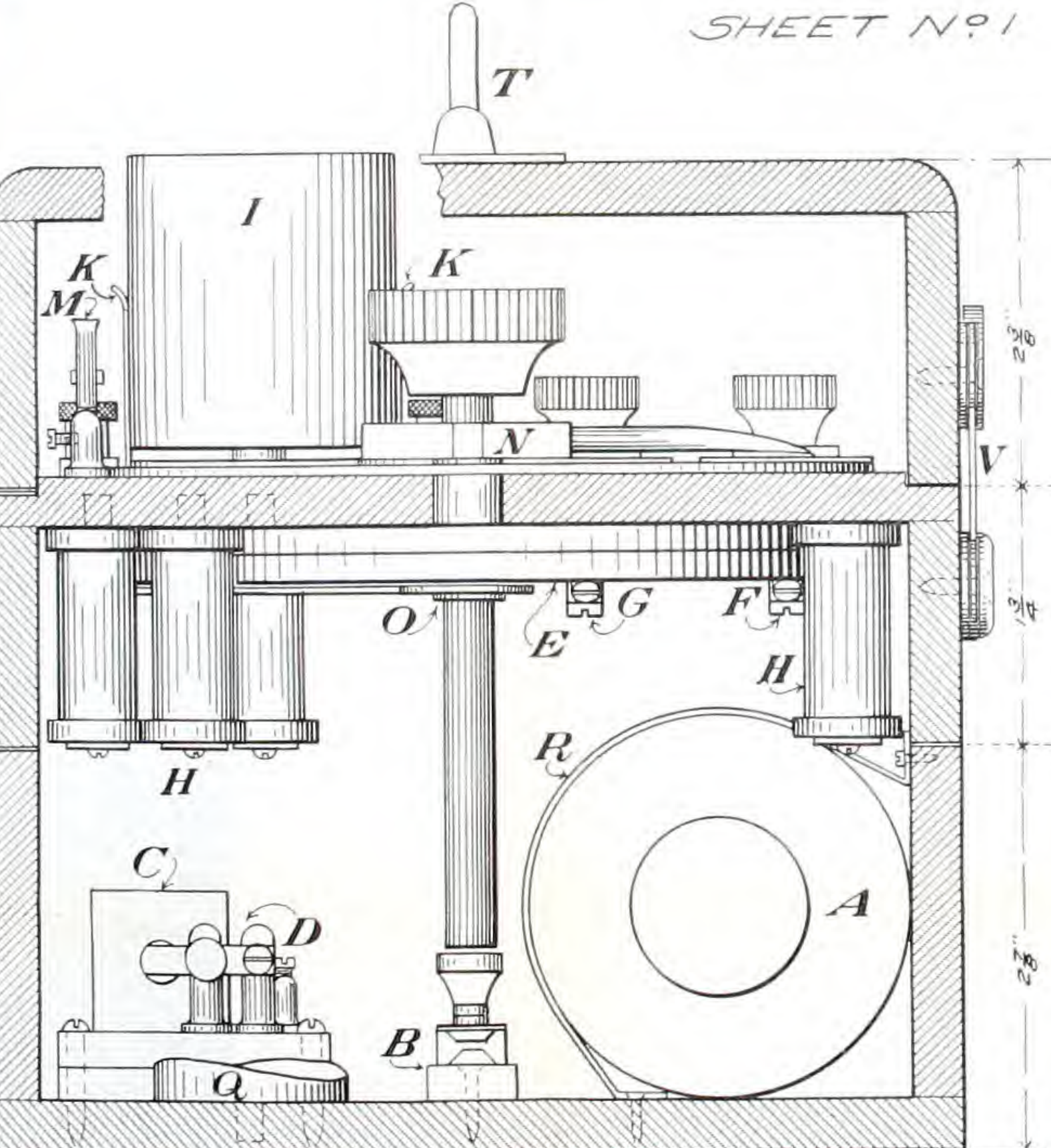
PLAN (COVER REMOVED)



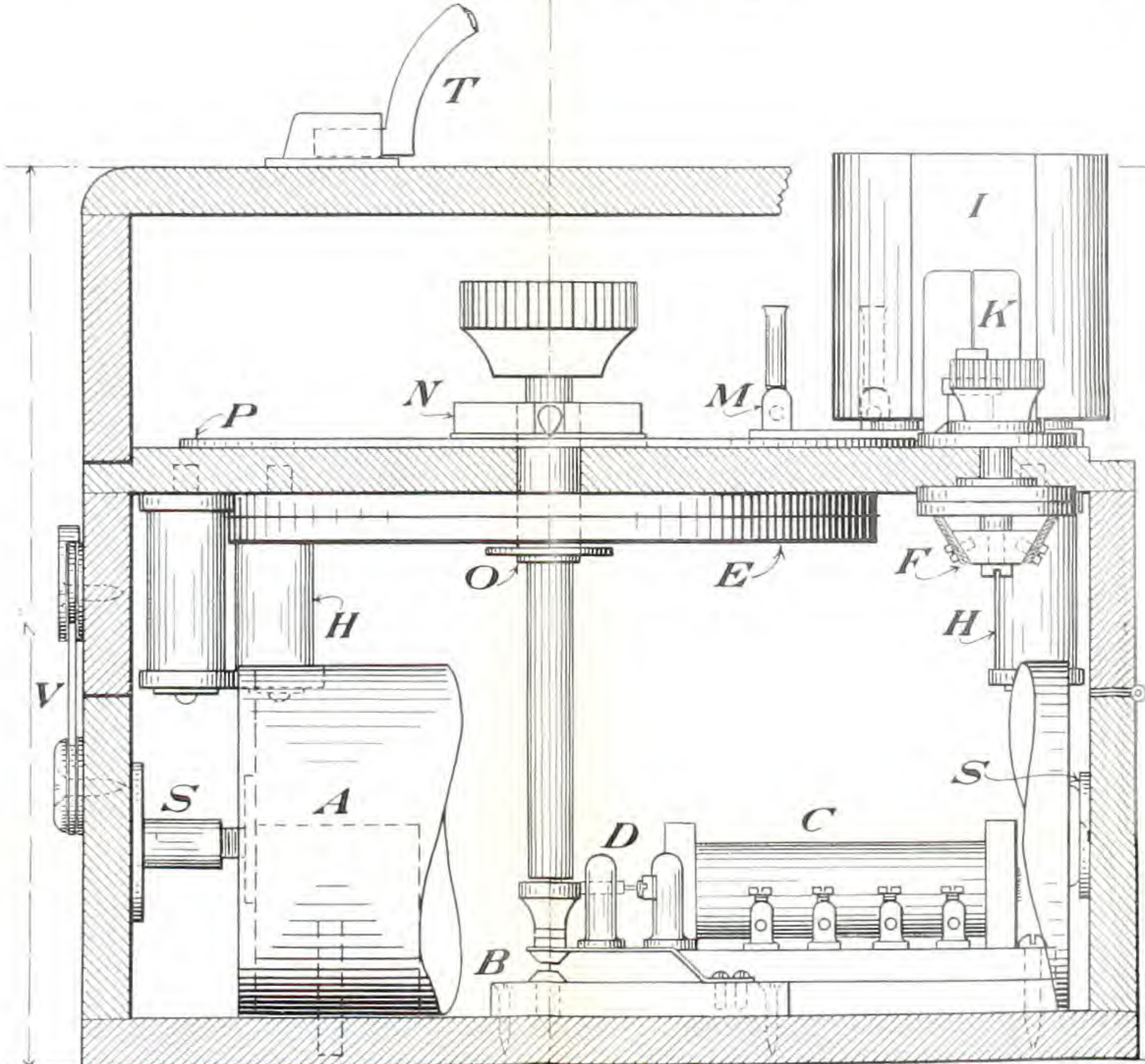
UNDER SIDE OF UPPER COMPARTMENT

SHEET N^o 1

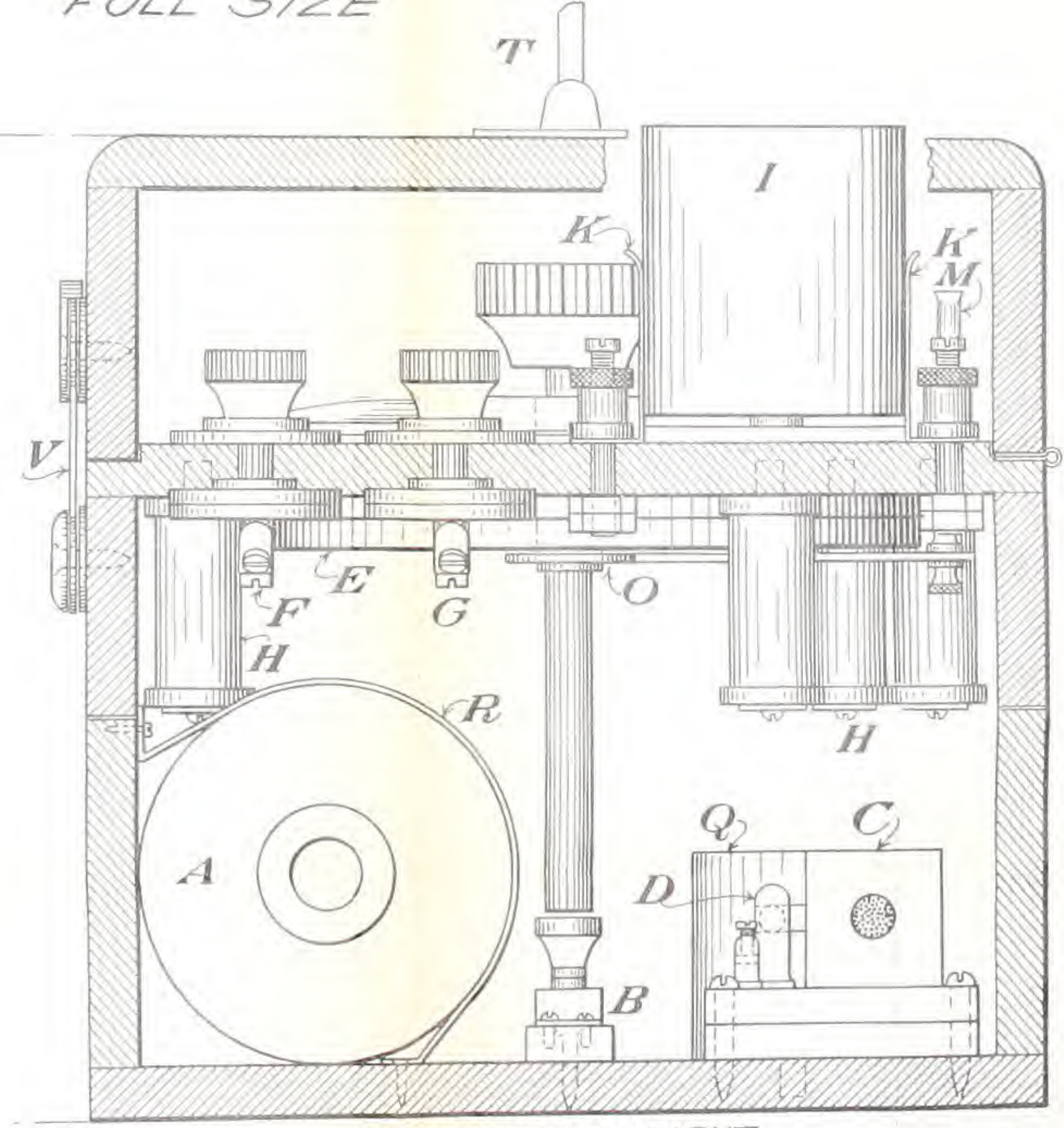
FULL SIZE



INTERIOR FROM LEFT



INTERIOR FROM FRONT

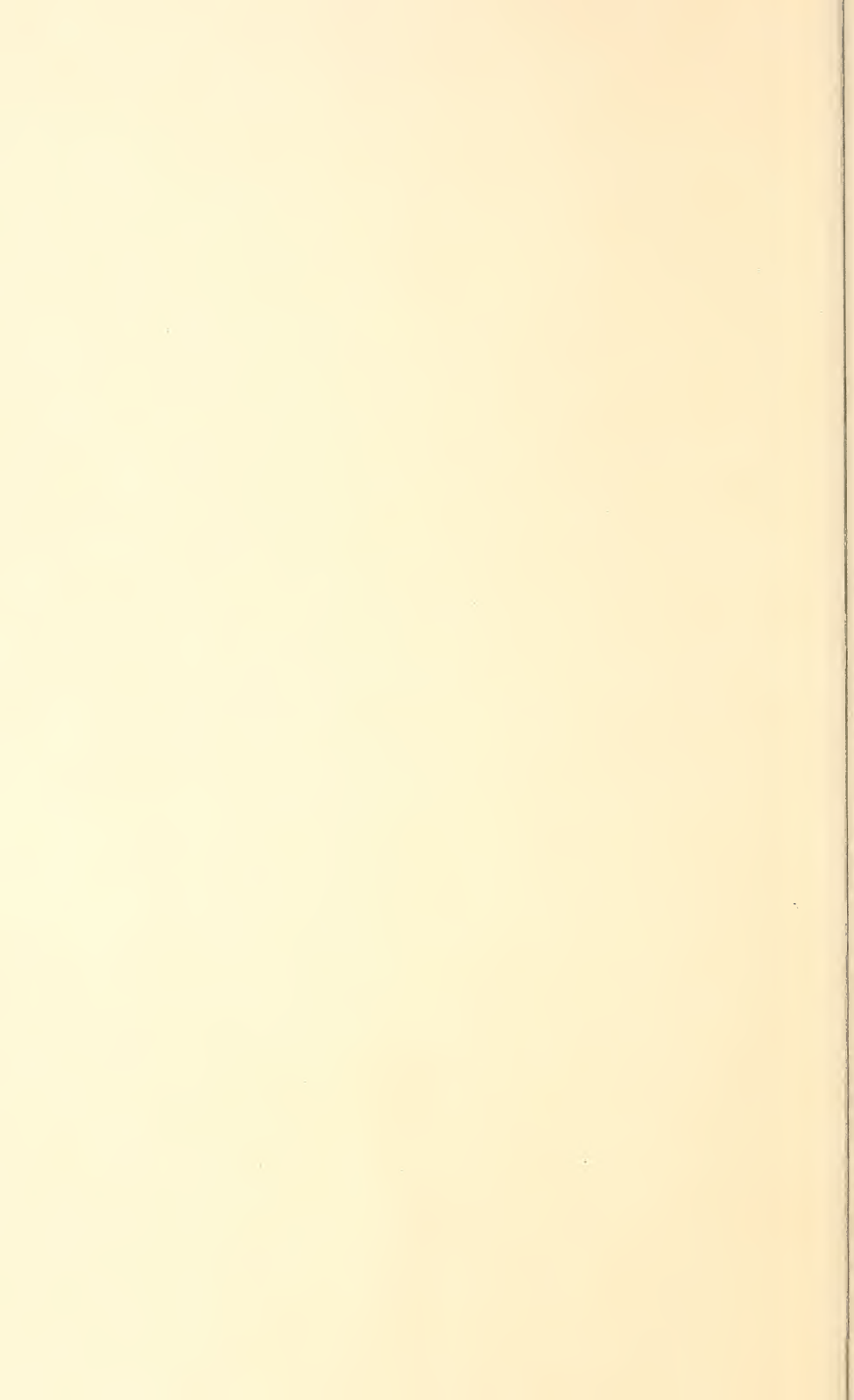


INTERIOR FROM RIGHT

DRAWINGS OF BRIDGE ASSEMBLED







No 31 drill
4x36 Thread
Hard rubber press button

4x36 Thread
B BATTERY SWITCH

No 31 drill
Brass spring

Brass contacts

Hard rubber base

2x256 Screen
5/32 Wood screw

C INDUCTION COIL AND BASE

D INTERRUPTER
6x32 Thread

Red fiber base

Felt 1/2" thick

5/8x5 Flat head screw

Cherry wood disk

Wire

E BRIDGE WIRE DISK

Hard rubber knob
5/8 Std. thread

Brass index pointer

5/8 Std. thread
6x32 Thread

No 42 drill
Brass dial

No 42 drill
Red fiber base for switch

2x36 Flat head screw
Brass rotary switch
.0550w

No 27 drill
Brass brush
No 31 drill
6x32 Thread
4x36 Thread

F ROTARY SWITCH

Hard rubber knob
5/8 Std. thread

Brass index pointer

5/8 Std. thread
6x32 Thread

No 42 drill
Brass dial

No 42 drill
Red fiber base for switch

2x36 Flat head screw
Brass rotary switch
.0550w

No 27 drill
Brass brush
No 31 drill
6x32 Thread
4x36 Thread

G ROTARY SWITCH

Hard rubber cup
I CUP WITH ELECTRODES

Brass electrodes

Brass

K CONTACT CLIPS

Cherry wood wood

Hard rubber plate

Brass

L BRASS CLIP

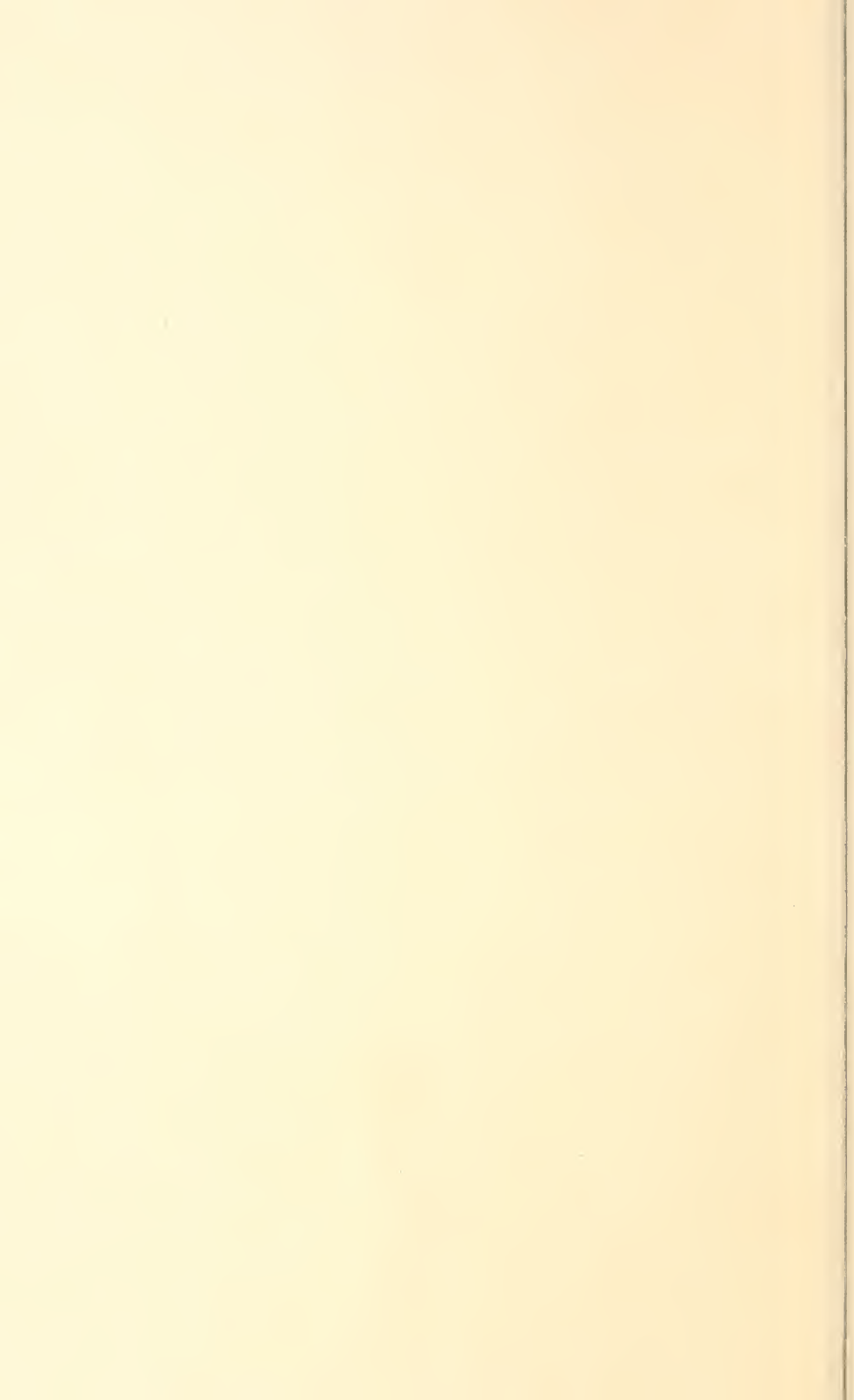
H RESISTANCE COILS

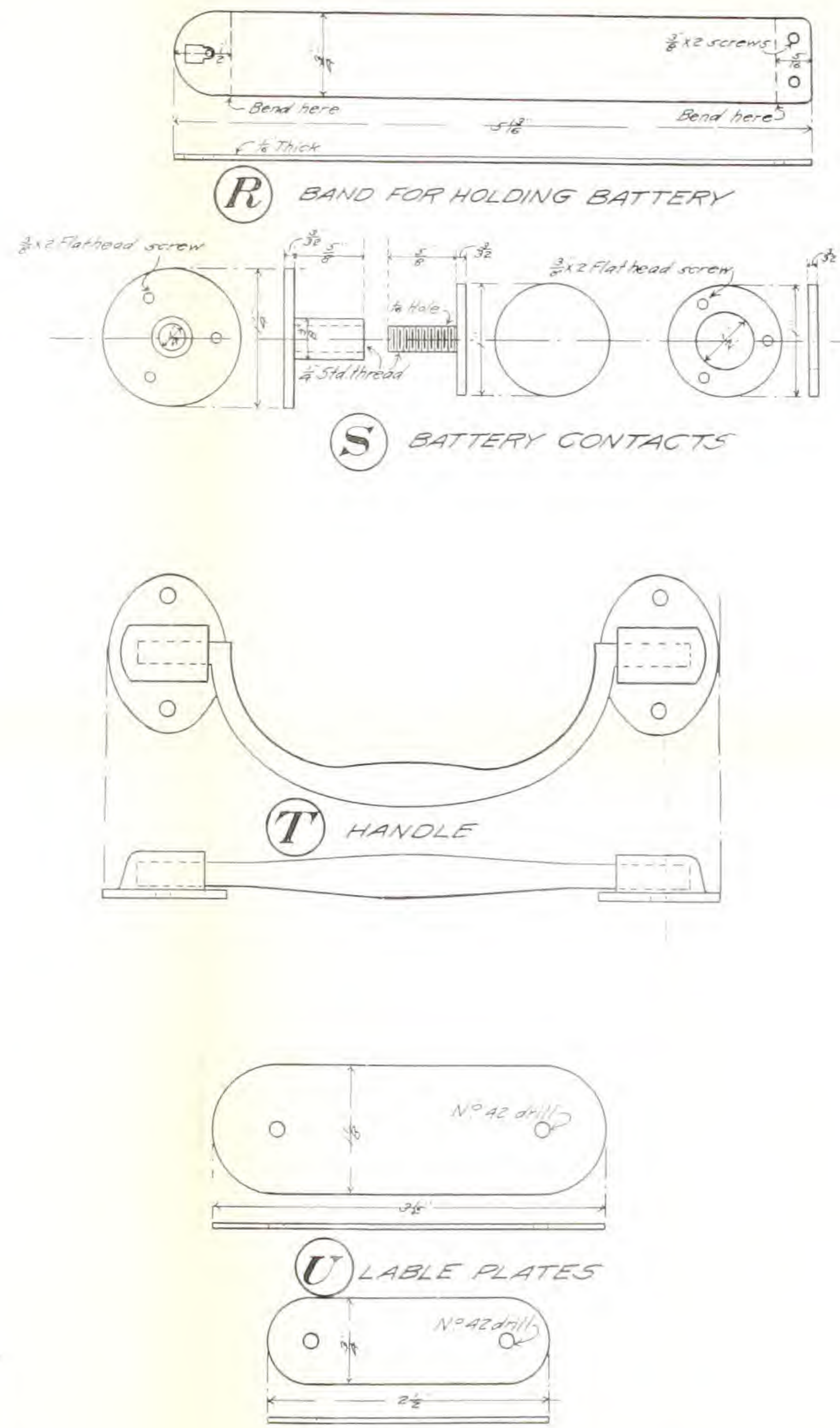
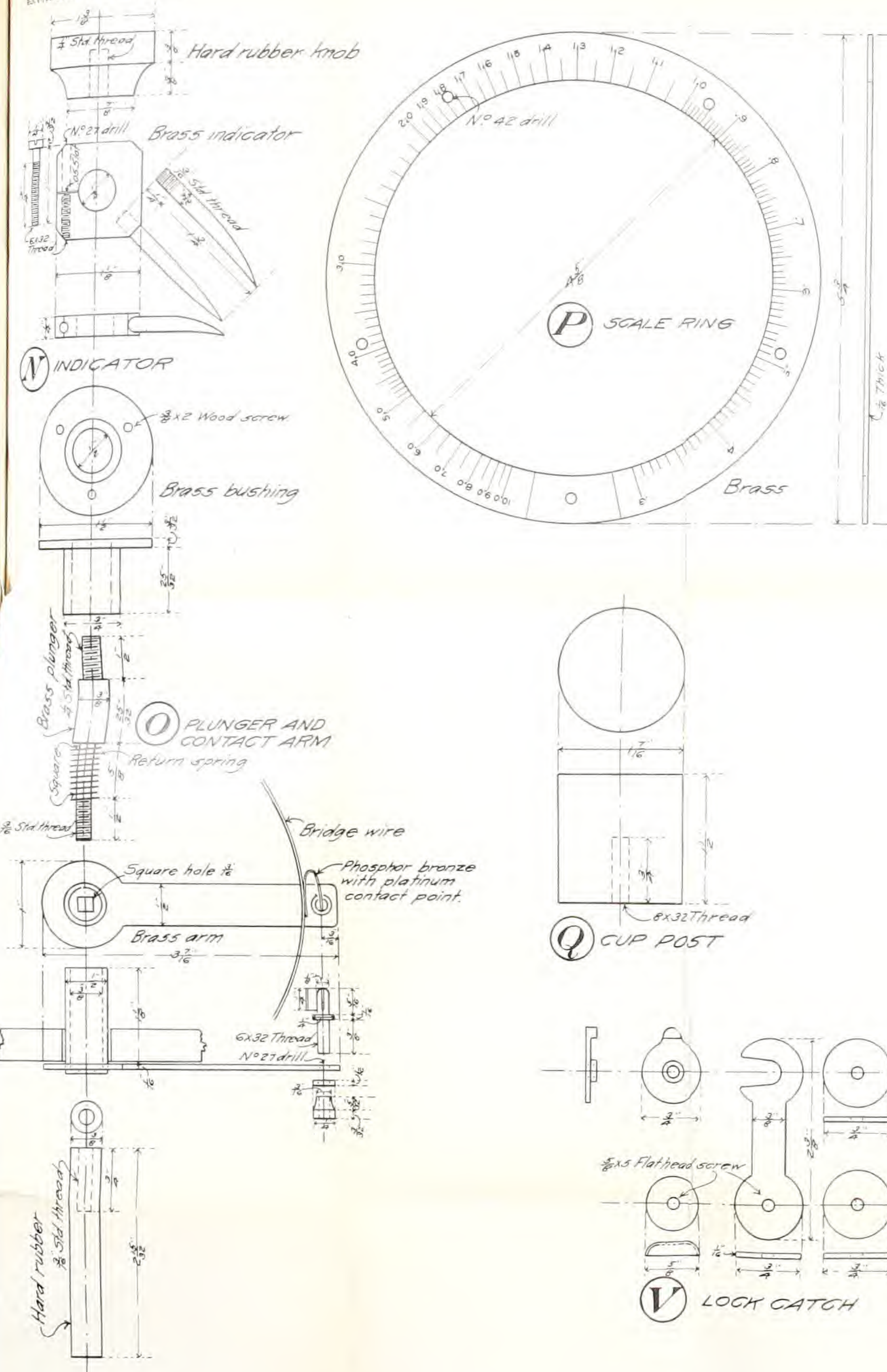
M TELEPHONE BINDING POST

FULL SIZE DETAILS
SHEET NO 2



PLATE V.





FULL SIZE DETAILS
SHEET N° 3

